Speculum Nauticum:

A

LOOKING GLASSE,

FOR

SEA-MEN:

WHEREIN THEY MAY behold a ſmall inſtrument called the Plaine *Scale: whereby all queſtions Nauticall, and* propoſitions Aſtronomicall are very *eaſily and demonſtratiuely* wrought.

Lately penned, and now publiſhed for the vſe and benefit of ſuch as will make good vſe of it.

¶ By IOHN ASPLEY Student in Phyſicke, and *Practitioner of the Mathematickes, in the* City of LONDON.

LONDON,

¶ Printed by *THOMAS HARPER.*

M. DC. XXIV.

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By IOHN ASPLEY Student in Physicke, and Practitioner of the Mathematickes, in the City of LONDON.

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TO

THE WORSHIPFVLL

the *Maſter, Wardens, and Aſſiſtants, of the Trinity* Houſe, in Debtford *Strand.*

ALbeit (Right Worſhipfull) there bee more eſſentiall natures contayned in each parte both of this Macrocoſme, & Microcoſme, exiſting in their abſolute being, then the vnderſtanding of man can fully apprehend, yet, I doubt not, but both thoſe which may with labour and diligence

be knowne, & thoſe alſo which of ingenious ſpirits and notable wits haue been inuented, and by them Artificially and Methodically taught, (tending not only to manifeſt profit in the Commonwealth, but alſo to the great encreaſe and ſetting forth of Gods diuine power, wiſedome, goodneſſe, prouidence, and encreaſe of vertue) ought of all men to bee embraced, (and eſpecially of thoſe which haue any gouernement, publique charge, or authority in the Common wealth) In regard that the neerer men approch to ſuch excellent vertues, the neerer (without doubt) doe they come vnto goodneſſe, to felicity, and to God himſelfe. Hence ſaith the Prophet (vnto men ſeated in eminent places) *dixi vos dij eſtis*, ſo that thoſe which either through arrogance, or ignorance deride, and contemne thoſe Arts (which with great dexterity, care, and induſtry haue beene found out, and left vntovs by the loue of our Predeceſſours) doe both offer contempt vnto the goodnes

of

of God, and doe much endamage and annoy all humane ſociety. So on the contrary part, they that do by all meanes further thoſe ſo profitable diſciplines, doe both render true honour vnto God, and doe greatly aduance the good of the Common-wealth wherein they liue. Now in regard there is no ſtudy (diuinity excepted) wherein the wit of man may be better employed, then in the motion of the Starres, and in the knowledge of their ſituation, place, and being, together with their wonderfull effects: In regard whereof I was incited to imploy ſome of my time in the ſtudy thereof, and at laſt conſidering that of the Orator, that *non nobis ſolum nati ſumus, &c.* Wee are not borne for our ſelues onely, but our friends challenge a part in vs, and our countreys come in for a ſhare, eſpecially thoſe honors and graces of our countrey, thoſe that trafique in the deepe, and haue their buſineſſe in the great waters, thoſe that are vnto this Iland as a woodden wall, the

Sea chariots, and the horses of England: these, I say, may lay claime iustly to the fruits of our labours, whatsoeuer they be which haue not altogether been abhorrent from the Mathematicall studies: considering this, I could do no lesse then bring in this my mite into their treasury, and *si quid ars mea efficere possit*, (if my skill can stand them in any stead) to further that so much deseruing Science of Nauigation. Accept therefore I beseech you this young sonne of my studies, this little handfull of paper, wherein is contained not *Anacreons* wanton Odes, or *Ouids* lasciuious Elegies, the incendiaries of lust, but a pure sparke of chaste and vestall fire, a small part of the Mathematicks: dedicated from a seruiceable affection to your Worships, that vnder the shield of your protections it may liue secure, from the desperate stab of criticall persons, and enuious spirites, who not onely like snarling Satyrs deride and contemne those so liberall Sciences, but swallow vp with despite (if it

were possible the professours thereof.) For rescue from such malignant spirites, my booke flies to the shadow of your fauour, which if you shall affoord vnto it, my labours shall bee all sacrificed vnto you, and I rest

Your Worships

bound seruant,

Iohn Aspley.

To

To the Reader.

Hauing euer since I came vnto vnderstanding (courteous Reader) practised my selfe in the Mathematicall Studies: and hauing attained vnto my desires therein, I am willing to impart some part of that knowledge which God hath bestowed vpon me, vnto the open view of the world: for the manifestation whereof, I haue freely giuen vnto thee this small Booke, being the first fruit of my labours, containing such Astronomicall and Nauticall questions as are wrought by the plaine Scale: which if I should find to receiue as free acceptance from thee, expect more of my labours in the same kind, and vntill then I rest.

Thy friend in affection.

Iohn Aspley.

Speculum Nauticum,

OR THE

SEA-MANS *GLASSE.*

THE FIRST BOOKE.

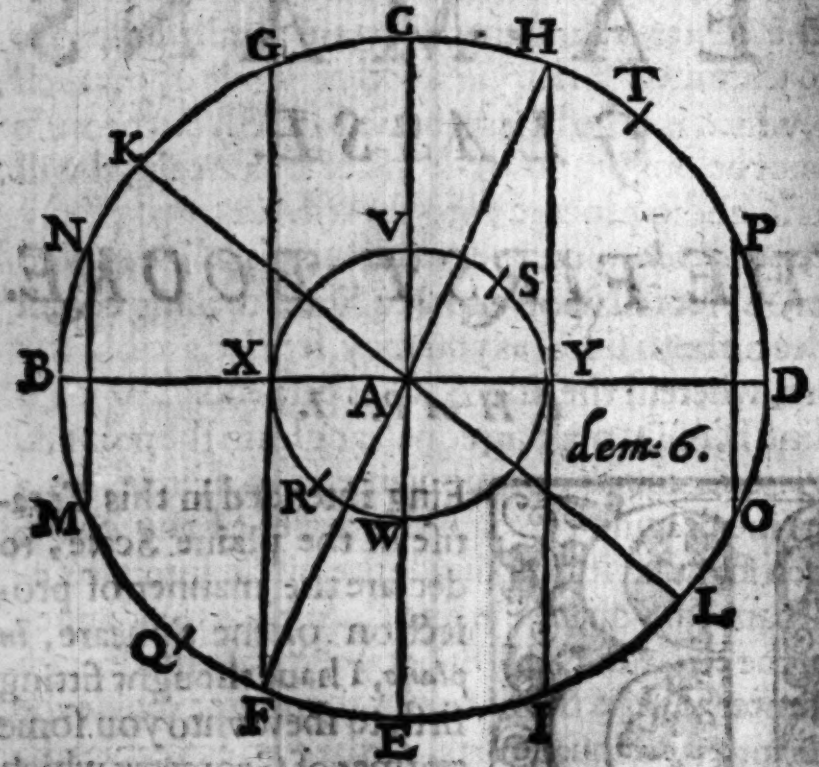
CHAP. 1.

BEing intended in this Treatiſe of the plaine Scale, to declare the manner of proiection of the Spheare, *in plano*, I haue thought fitting firſt, to ſhew vnto you ſome tearmes of Geometry which are neceſſary for the vnlearned to know, (for whoſe

ſake chiefly I write this Treatiſe) before they enter into the definition of the Spheare. Firſt therefore I intend to relate vnto you, what a point or pricke is, and afterward a line both right and crooked, and ſuch ſorts thereof as are appertinent vnto the operations and vſe of this Scale.

Punctum, or a point, is the beginning of things, or a pricke ſuppoſed indiuiſible, void of length, breadth, and depth: as in the figure following is noted by the point, or pricke A.

Linea, or a line, is a ſuppoſed length, or a thing extending it ſelfe in length, not hauing breadth, nor thickneſſe, as is ſet foorth vnto you by the line B A D.



Parallela, or a Paralell line, is a line drawne by the ſide of another line, in ſuch ſort, that they may be

beequidistant in all places. And of such paralels, two onely belong vnto this worke of the plaine Scale, that is to say the right lined paralell, and the circular paralell.

Right lined parallels are two right lines equidistant one from another, which being drawne foorth infinitely, would neuer touch or meet one another, as you may see in the figure where the line, H. I. is parallell vnto the line C. E. and the line G. F. is parallell vnto them both.

A circular parallell is a circle drawne either within or without another circle vpon the same center, as you may plainely see by the two circles B. C. D. E. and X. V. Y. W. These circles are both drawne vpon the center A. and therefore are parallell the one vnto the other. There is another kinde of parallell also, which is called a serpentine paralell, but because it is not belonging vnto the vse of this *Scale*, I will omit it, and so proceed vnto the rest.

Perpendiculum, or a perpendicular is a line raysed from, or let fall vpon another line, making equall angles on both sides, as you may see declared in the figure, wherein the line A. C. is perpendicular vnto the line B. A. D. making equall angles in the point A.

Diameter circuli, or the diameter of a circle, is a right line drawne through the center of any circle, in such sort that it may diuide the circle into two equall parts, as you see the line B. A. D. is the diameter of the circle B. C. D. E. because it passeth through the center A. and the two ends therof doe diuide the circle into two equall parts, in the two extreames B. and D. making the semicircle B. C. D. equall vnto the semicircle D. E. B.

Semidiameter circuli, or the semidiameter of a cir-

cle, is halfe of the Diameter, and is contained betwixt the Center, and the one side of the circle, as the line A. D. is the Semidiameter of the circle B. C. D. E.

Semicirculus, or a Semicircle, is the one halfe of a circle, drawne vpon his Diameter, and is contained vpon the Superficies, or Surface, of the Diameter, as the Semicircle B. C. D. which is halfe of the circle B. C. D. E. and is contained aboue the Diameter B. A. D.

Quadrans circuli, is the fourth part of a circle, and is contained betwixt the Semidiameter of the circle, and a line drawne Perpendicular, vnto the Diameter of the same circle, from the Center thereof, diuiding the Semicircle into two equall parts, of the which parts, the one is the Quadrant, or fourth part of the same circle. As for example, the Diameter of the circle B. C. D. E. is the line B. A. D. diuiding the circle into two equall parts: then from the Center A. raise the Perpendicular A. C. diuiding the Semicircle, likewise into two equall parts; so is A. B. C. or A. C. D. the Quadrant of the circle B. C. D. E. which was desired.

CHAP.

CHAP. II.

The maner how to raise a Perpendicular from the middle of a line giuen.

DRaw first a ground line whereupon you would haue a Perpendicular raised, then open your Compasses vnto any distance (so it exceed not the end of your line,) placing one foote of the said Compasses, in the point from whence the Perpendicular is to be raised, and with the other foote make a marke in the line on both sides, then remooving your Compasses vnto any other distance that is greater, and set one foote thereof, in one of the markes, and with the other foote make a marke ouer the middle Point, then with the same distance of your Compasses, set one foote in the other marke vpon the line, and with the other foote make another Arch of a Circle ouer the middle Point, so that it may crosse the first Arch, and from the meeting of these two Arches, draw a right line vnto the middle Point, from which the Perpendicular was to be raised, which line shall be the Perpendicular desired.

Example, suppose your Base or ground line where vpon a Perpendicular is to be raised by the line F. L. K. and from L. the Perpendicular is to be raised, set one foote of your Compasses in the Point L. and with the other, make the markes G. and M. on both sides of the Point L. then opening your Compasses wider, set one foote in the Point M. and with the other draw the Arch S. ouer the Point L. then with

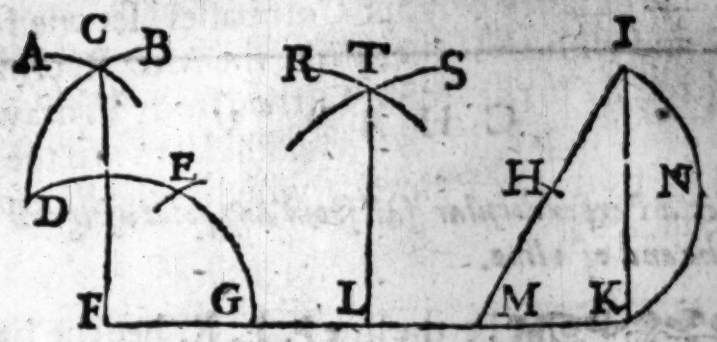
the same distance of your Compasses, set one foote in G. and with the other make the Arch R. crossing the Arch S. in the Point T. then from T. draw the line T. L. which line is Perpendicular vnto the line F. L. K. from the Point L. which is the Perpendicular desired.

CHAP. III.

To let a Perpendicular fall from any Point assigned, vnto the middle of a line.

LEt the line whereupon you would haue a Perpendicular let fall, be the line L. F. K. and the point assigned, to bee the point T. from whence you would haue a Perpendicular let fall vpon the line .F. L. K. first set one foote of your Compasses in T and open your Compasses vnto any distance so that it be more then the distance T. L. which here wee suppose to bee the distance T. M. then make in the line F. L. K. the markes G. and M. then with your Compasses, take the one halfe of G. M. which is in the point L. then from L. draw a line vnto the point T. so the line T. L. shall bee the Perpendicular, which was desired to be let fall from the assigned point T. vnto the middle of the line F. L. K.

CHAP.



CHAP. IIII.

To raise a Perpendicular vpon the end of a line.

SVppose the line whereupon you would haue a Perpendicular raised, bee the line F. L. K. and from the point F. a Perpendicular is to bee raised: first open your Compasses vnto any distance, which here wee put to bee the distance F. G. and set one foote of your Compasses in the point F. and with the other draw the Arch D. E. G. then set one foote of your Compasses in the point G. and with the other draw the Arch E. then placing one point of your Compasses in E. with the other draw the Arch D. B. then place your Compasses in D. and with the same distance, draw the Arch A. cutting the Arch D. B. in C. then draw a line from C. vnto the end of the line F. L. K. vnto the assigned point F. so shall the line C. F. bee a Perpendicular raised from the end of the line F. L K. and from the assigned point F.

CHAP.

CHAP. V.

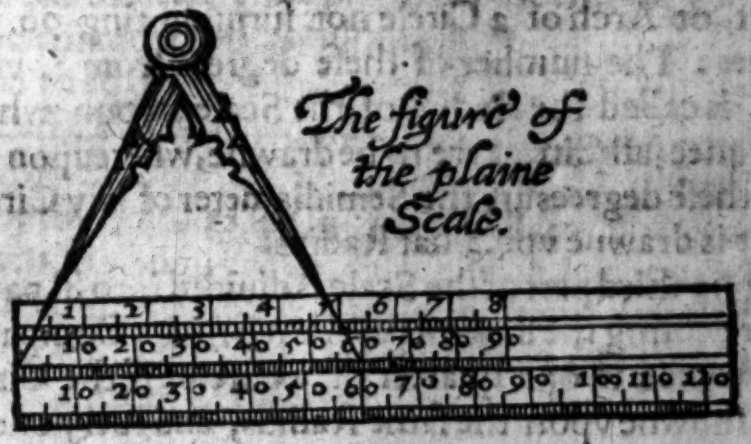
To let a Perpendicular fall from any point assigned vnto the end of a line.

LEt the line F. L. K. bee the base or groundline, and from the point I. a Perpendicular is to be let fall, vpon the end of the line K. first from the assigned point I draw a line vnto any part of the base, which shall be the line I.H.M. then finde the middle of the line I. M. which is at H. place therefore one foot of your Compasses in the point H. and extend the other vnto I. with which distance draw the Arch I.N. K. vpon the Center H. cutting the Base or Groundline in the point K. then draw the line K. I. which line shall be the Perpendicular desired,

NOw I doubt not but you vnderstand the way to let fall, or to raise, any manner of Perpendicular line either from, or vpon any part of a line: therfore now I intend to proceed vnto the maine point here aimed at, which is, to declare, and make known vnto you the seuerall operations performed by the plaine Scale, which though it bee in vse with very few, yet it is most necessary for Sea men, because all questions in Nauigation are thereby easily and plainly wrought. And also all questions in Astronomy (belonging vnto the expert, and industrious Sea men) may both speedily and easily bee wrought by the same Scale: in regard whereof I haue declared

in

in this little Booke, that knowledge (which God hath beene pleaſed to beſtow vpon mee) concerning the neceſſary vſe and practice thereof ; hoping that you will as kindly accept it, as it is freely offered vnto your courteous conſiderations.



The figure of the plaine Scale.

CHAP. VI.

Of the deſcription of the Scale.

THis Scale vſually is diuided into three parts, the firſt whereof is a Scale of equall Leagues, diuided into Degrees, or Leagues from 1. vnto 100. and vpwardes at your pleaſure, and numbred with 10. 20. 30. 40, and ſo foorth vnto the end. All theſe diuiſions are equall one vnto another, and is in vſe for to meaſure the Leagues that any ſhip hath runne vpon any Courſe, or the Leagues that ſhe hath raiſed

or depreſſed the Pole, or departed the Meridian, as in the worke, hereafter ſhall bee more fully declared.

The ſecond part of the Scale, is the ſingle Corde of of a Circle, or the Corde of 90. and is diuided into 90. vnequall diuiſions, repreſenting the 90. degrees of the Quadrant: & are numbred with 10. 20. 30. 40. &c. vnto 90. This Corde is in vſe to meaſure any part, or Arch of a Circle not ſurmounting 90. degrees: The number of theſe degrees from 1. vnto 60. is called the Radius of the Scale, vpon which diſtance, all Circles are to be drawne, whereupon 60. of theſe degrees are the Semidiameter of any Circle, that is drawne vpon that Radius.

The third part of the Scale is diuided into 8. parts, repreſenting the 8. points of the Mariners Compaſſe, contained in one quarter of a Circle, if the Circle bee drawne vpon the ſame Radius, and euery one of the aforeſaid points, is (for exactneſſe ſake) ſubdiuided into 8. ſmaller parts.

I haue likewiſe cauſed two other lines to be placed vpon the backeſide of the Scale, which I doe call the firſt and ſecond lines of Longitudes: the firſt is diuided into 20. vnequall parts, or leagues, which 20. leagues are equall vnto the coard of 90. The vſe of this firſt line of Longitudes, is to ſhew how many leagues and miles in any Parallell, doe anſwere vnto one degree of the Equinoctiall.

The ſecond line of Longitudes is diuided into 100. proportionall parts, or into 100. vnequall leagues; and euery league is ſubdiuided into miles, and halfe miles. The vſe of this line is thus: when you haue found by the firſt line of Longitudes, how many

leagues

leagues and miles doe answere vnto a degree of the Equinoctiall in any latitude you desire: this second line will shew you how many degrees any number of leagues in that parallell, will answere vnto, in Equinoctiall circle.

Thus hauing shewed you the parts of the Scale, and vnto what vse they doe generally serue, I will proceed to declare the particular vse thereof, in the Art of Nauigation, as followeth.

CHAP. VII.

To finde how much any ship hath raised or depressed the Pole, knowing the course she hath made, and the leagues that she hath sailed.

THE Course is Southwest and by South, the leagues sailed are 100. the difference of Latitude is demanded.

In the first demonstration, draw first the line A. B. and vpon the Center A. raise a perpendicular A. F. Then opening your Compasses vnto the *Radius* of your Scale, and set one foot thereof in the Center A. and with the other draw the Arch K. C. B. then in regard your course is Southwest and by South, that is, three points from the South, take three of the eight points of the Compasse with your Compasses, and place them from K. vnto C. then draw the line A. C. D. and place the distance of the leagues you haue sailed

(which are 100.) vpon the line A. C. D. from A. vnto D. Then from D. draw the line D. F. parallell vnto A. B. cutting the Meridian A. K. F. in the point F. then take the distance of F. A. and apply it vnto the scale of equall leagues, and you shall finde it iust 83. leagues, or 4. degr. 9. min. which are the degrees you haue altered the Latitude, which degrees and minutes (if the latitude from whence you departed, be South) must bee added vnto the latitude from whence you departed, and you shall haue the latitude that you are in: contrariwise, substract them (if the Latitude from whence you departed, bee North) and you haue likewise the Latitude that you are in.

CHAP. VIII.

The distance of latitude and leagues sailed being giuen, to finde the distance Meridionall, and consequently the difference of longitude.

Sailing from the North parallell of 56. degr. and 5. min. 100. leagues betwixt South and West, vntill the Pole be depressed 4. degr. 9. min. the difference of longtitude is demaunded.

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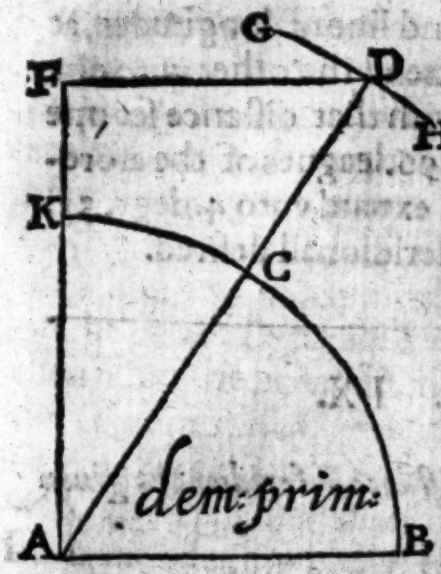


IN the first Demonstratiō draw the Quadrant A K. C. B. as is taught in the last Chapter. Then reduce your degrees of Latitude into Leagues, which is done by multiplying of them by 20. the product will be 83. leagues, which leagues being applied vnto the Meridian line A. K. F. they will end in the point F. Then from F. draw the line D. F. parallell vnto A. B. Then open your Compasses vnto the distance of 100. leagues of your Scale of equall parts, and set one foot of your Compasses in the point A. and with the other draw the Arch G. H. cutting the line F. D. in D. so shall the distance D. F. be the distance of the Meridian, from the Meridian, from whence you departed, which (being applied vnto the Scale) is 56. leagues. Then in regard you sailed from the North parallell of 56. degr. and 5. min. vntill you had depressed the Pole 4. degr. 9. min. Substract therefore 4. deg. 9. min. from 56. degr. 5. min. and there remaineth 51. degr. 56. min. which is the latitude of the place you are in, and in that parallell haue you departed the first Meridian 56. leagues. Then opening your Compasses vnto 51 degr. 56. min. of your Cord, and apply it vnto the first line of longitudes, and you shall finde that 12. leagues and one mile (in that parallell) doe alter one degree of longitude. Then set one foot of

your Compaſſes in the ſecond line of longitudes, at 12. leagues, one mile, and extend the other vnto one degree of that line; then with that diſtance ſet one foot of your Compaſſes in 56. leagues of the aforeſaid line, and the other will extend vnto 4. degr. 33. min. which is the diſtance Meridionall deſired.

CHAP. IX.

By diſtance of latitude and diſtance Meridionall, given to find the Rumbe.

SAiling from the North parallell 66. degrees: 20. min. vntill the Pole be depreſſed foure degrees and 9. min. and the diſtance Meridionall, or difference of longitude, ſixe degrees to find the Rumbe is required.

By the firſt demonſtration, draw the Quadrant A. K. C. B. then turne your foure degrees nine minutes into Leagues, it maketh eighty three Leagues; which place vpon the line A. K. F. from A. vnto F. then ſubſtract the difference of the two latitudes, from the number of the firſt Latitude, and it leaues the ſecond Latitude, 62. deg. 11. min. Then opening the Compaſſes vnto the middle laritude, which is ſixty foure degrees and fifteene minutes of the Corde, applying it vnto the firſt Line of Longitudes, and you ſhall find eight Leagues, two miles, and foure ſecondes to anſwere vnto one degree: then ſet your Compaſſes in one degree, in your ſecond line of longitudes, and extend

the

the other foot vnto eight leagues, and two miles and foure ſeconds: then with that diſtance of the Compaſſes, place the one foot at ſixe degrees of that line, and turne the other vpward, and it will extend vnto fifty ſixe leagues, therefore open your Compaſſes to the diſtance of fifty ſixe leagues, in the line of equall leagues, and apply them from the point F. vpon the line F. D. paralell vnto A. B. from F. vnto D. then from the point D. draw the line D. A. cutting the Quadrant K. C. B. in C. ſo ſhall K. C. bee the diſtance of the Rumbe from the South Weſtward, which is iuſt thirty three degrees forty fiue minutes from the South, which is South Weſt and by South, the Rumbe deſired.

CHAP. X.

By the latitude of two places, and diſtance vpon the Rumb to finde the leagues ſailed.

The Pole depreſſed three degrees thirty minutes, the Rumb the fourth from the Meridian.

IN the ſecond demonſtration draw the line A. E. then from A. raiſe the Perpendicular A. C. then opening the Compaſſes to the diſtance of the Radius, placing one foot thereof in the center A. and with the other drawe the Quadrant B. D. E. Then reduce your three degrees, thirty minutes into leagues,

counting for euery degree twenty leagues, and for the thirty munites ten leagues, ſo they make ſeuenty leagues; then open your Compaſſes vnto ſeuenty degrees in the line of equall partes, and place them vpon the line A, B. C. from A. vnto C. then from C. draw the line C, F. parallell vnto A. E. Then in regard your Rumb was the fourth from the South, take foure of the eight points of the Compaſſe, and place them vpon the Quadrant from B. vnto D. then from A. by the point D. draw the line A. D. F. cutting the line C. F. in F. So ſhall the diſtance betwixt A. and F. be the number of Leagues (vpon the fourth Rumb) before you can either raiſe or depreſſe the Pole 3. deg. 30. min. which is here found to be ninety nine Leagues.

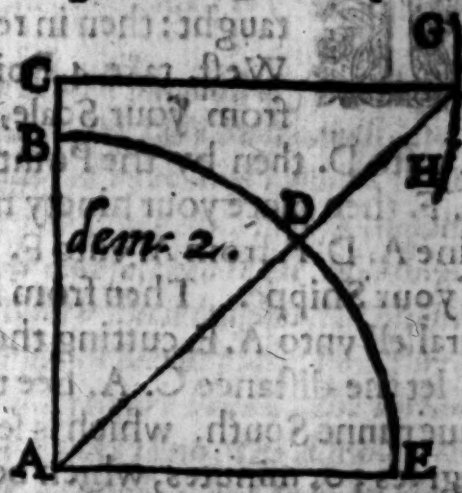
CHAP. XI.

To find the diſtance of any Iland from you, that you may diſcerne by two Stations, knowing the point of the Compaſſe, the Iland beareth vnto each of the Stations.

Suppoſe (being at Sea you diſcouer an Iland bearing Southweſt of you, which place let it bee your firſt Station, and ſeuenty Leagues ſailing South obſerning the Iland to beare Weſt of you, which let be the ſecond Station, the demand is to finde the diſtance of the Iland from both the Stations.

In

IN the second Demonstration let A. be the first Station, and vpon the Center A. draw the Quadrant A. B. D. E. then in regard you found the Iland to beare Southwest from you, therefore take foure of your eight points of Compasse, and place them vpon your Quadrant from E. vnto D. then from the Center A. by the point D. drawe the Line A. D. F. representing the Visuall Line passing betwixt your sight & and the Iland, being in the first Station. Then sailing seuenty Leagues South, which is from A. your first Station, vnto C. the second Station: then obseruing the Iland to beare West of you, therefore from the point C. the second Station, draw the Line C. F. parallell vnto A. E. cutting the Line A. D. F. in the point F. so shall the point F. be the place of the Iland desired, and the distance A. F. is the distance of the Iland from the first Station, which is iust ninetynine Leagues off the Line of all parts. And likewise the distance from C. vnto F. is the distance of the Iland from the second Station, which is here found to be iust seuenty Leagues: and by this maner of worke you may finde the distance of any Iland from you, which you may discerne either by Sea or land.



CHAP.

CHAP. XII.

Sailing from the South Latitude of 60. degrees 51. min. and from Longitude 25. degrees 24. min. 99. Leagues, vpon a Southwest Course: the Latitude and Longitude of the second place is demanded.

IN the second Demonstration, draw the Quadrant A. B. C. D. E. as is formerly taught: then in regard you Saile South-West, take 4. Pointes of the Compasse from your Scale, and place them from B. vnto D. then by the Point D. draw the Line A. D. F. then place your ninety nine Leagues vpon the Line A. D. F. from A. vnto F. so shall F. be the place of your Shippe. Then from F. draw the Line F. G. parallell vnto A. E. cutting the Line A. B. C. in G. so let the distance C. A. bee the Leagues that you haue runne South, which is seuenty Leagues; or 3. degrees 30. minutes, which being added to the Latitude from whence you departed, makes sixty foure degrees and twenty one minutes for the Latitude of the second place: then take the distance C. F. and apply it vnto the Line of Equall partes, and you shall find it likewise seuenty Leagues: then opening your Compasses vnto the middle Latitude 62. degrees 30. minutes in the Line of Cordes, and apply it vnto the first Line of Longitudes, you shall finde that nine Leagues and 10. miles, and 38. seconds, doe alter a degree of Longitude, then placing one foot of the Compasses in the second Line of Longitudes, at 99. Leagues and thirty eight seconds, and extend the other to one, then keeping the distance of the Com-

passes,

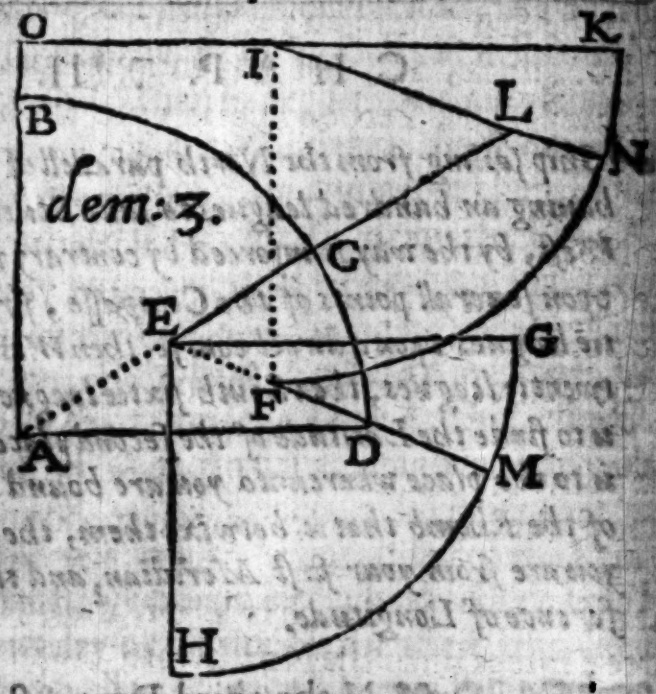
passes, set one foot in the seuenty Leaues of the same Line, & the other foot will extend vnto 7. degr. 37. min. which being substracted from the Longitude from whence you departed, leaues seuenteen degrees and forty seuen minutes for the Longitude of the second place.

CHAP. XIII.

A Ship sailing from the North parallell of fiftie d[illegible]grees, hauing an hundred leagues to saile South-west, and by West, by the way is inforced by contrary winds, to saile vpon seuerall points of the Compasse, first sailing thirtie leagues vpon a direct course, then West, North-west twentie leagues, then South sixtie leagues, the question is to finde the Latitude of the second place, how farre it is to the place whereunto you are bound, the distance of the Rhomb that is betwixt them, the distance that you are from your first Meridian, and thereby the difference of Longitude.

IN the third Demonstration, draw the line A. D. and from the point A. raise the Perpendicular A. B. then open your Compasses vnto the Radius of your Scale, and place one foote thereof in the Center A. and with the other draw the Quadrant B. C. D. then take three points of the Compasse & place thē vpon the Quadrant from D. vnto C. then from the Center A. by the point C. draw the Line A. C. L. 100. Leagues in length, which is the true course you are to saile.

Then in regard you ſailed thirty Leagues direct, take thirty degrees from your Scale of Equall partes, and place them vpon the Line A. E. C. extending from A. vnto E. then in regard you turned your courſe, Weſt, Northweſt, from the Center E. draw the Line E. G. parallell vnto A. D. and againe from the Center E. draw the Line E. H. Perpendicular to E. G. and paralell vnto A. B. then with the diſtãce of the Radius ſet one foote of your compaſſes in the Center E. and with the other drawe the Quadrãt G M. H. and in regarde you ſailed Weſt, North-weſt, which is two pointes from the Weſt, North ward, take from your Scale two pointes of the Compaſſe, and place them vpon the Quadrant G. M. H. from G. vnto M. then from the Center E. vnto the point M. draw the line E. F. M. then take twentie Leagues with your Compaſſes from the Scale of equall parts, and place them vpon the line E. F. M. from E. vnto F. then is your Ship in the point F. Laſtly in regard you runne South ſixtie Leagues, from F. draw a line parallell vnto the Meridian



dian A. B. which is the line F. I. then take from your Scale of equall parts sixtie Leagues, and place them from F. vnto I. then is your Ship in the point I. then last of all is to bee found how farre it is to the place whereunto you were bound, the distance of the Rhomb that is betwixt you, the degrees and minutes you haue raised the Pole, the distance of departure from the first Meridian, and thereby the difference of Longitude, and that you may so doe, first draw the line O. I. K. Perpendicular vnto the line I. F. in the point I. and with your Compasses opened vnto the distance of the Radius, set one foote of your Compasses in the Center I. and with the other draw the Quadrant K. N. F. then in regard your Ship is in the point I. and the place whereunto you are bound is the point L. therefore from I. through the point L. draw the line I. L. N. cutting the Arch K. N. F. in the point N. therefore let I. L. bee the Leagues you haue to the place whereunto you are bound, which is fortie one Leagues and a halfe, and the Rhomb the distance K. N. which is West, and by North, and three degrees vnto the Northward, so likewise is the line A. O. the number of Leagues you haue runne due South, which is sixtie eight Leagues and one mile, or three degrees and twentie fiue minutes, which being taken from fiftie degrees, the parallell from which you departed, leaues fortie sixe degrees and thirtie fiue minutes for the parallell you are in. Last of all, shall the line I. O. be the Leagues that you haue departed your first Meridian, which are fortie two Leagues & one mile: then open your Compasses vnto fortie eight degrees seuenteene minutes & thirtie seconds of the line of Cordes, which is the middle

Latitude, and applie it vnto the first line of Longitudes, you shall finde that thirteene Leagues o mile, fiftie sixe seconds doe answere vnto a degree of Longitude in that parallell, then setting one foote of your Compasses in thirteene Leagues, and fiftie sixe seconds in your second line of Longitudes, extending the other vnto one degree, then with the same distance of your Compasses, set one foote in fortie two Leagues and one mile of the same line, and the other will shew you three degrees and thirteene minutes, which is the difference of your Longitude desired.

CHAP. XIIII.

Two Ships departing from one parallell, and Port, the one in sailing eightie Leagues betwixt the North, and the West, hath raised the Pole two degrees, the other in sailing a hundred Leagues betwixt the North, and West, hath raised the Pole foure degrees, I demand by what Rhombes the said Ships haue sailed, and the Rhomb, and distance that is betwixt them.

IN the fourth Demonstration, draw the Quadrant A. B. C. D. E. then in regard the first Ship hath raised the Pole two degrees, which is fortie Leagues, take fortie Leagues of your Scale, and applie them vnto the Meridian line A. G. L. from A. vnto G. then from the point G. draw the line G. F. parallell vnto A. B. then opening your Compasses vnto eightie

Leagues,

Leagues, set one foote in the Center A. with the other make a marke in the line G. F. which will bee at F. so shall F. bee the place of the first Ship; the second Ship hath raised the Pole foure degrees, which is eightie Leagues, therefore place eightie Leagues vpon the Meridian line A. G. L. from A. vnto L. and from the point L. draw the line L. M. parallell vnto G. H. F. then open your Compasses vnto the distance of a hundred Leagues, which are the Leagues the second Ship did runne, and set the foote of your Compasses in the Center A. & with the other make a marke in the line L. M. which will bee at M. then draw the line M. A. which is the course of the second Ship, and the line F. A. is the course of the first Ship, then from F. let a Perpendicular fall, being Perpendicular to the line G. F. which is the line F. K. then opening your Compasses vnto the Radius of your Scale, set one foote in the Center F. and with the other draw the Quadrant H. I. K. likewise from F. the place of the first Ship, draw a line by the point M. the place of the second Ship: cutting the quadrant K. I. H. in I. so let I. K. bee the course that is betwixt them; that is, if you will saile from the first Ship vnto the second, you must saile North, and by East, and one and fortie minutes to the Eastward, likewise let F. M. bee the distance that is betwixt them, which in this Demonstration is fortie Leagues, two miles, so shall B. C. bee the course of the first Ship from the West Northward, which here is found to bee thirtie degrees and one minut from the West Northward, or North West, by West, and three degrees and fortie foure minutes to the Westward. Lastly the arch E. D.

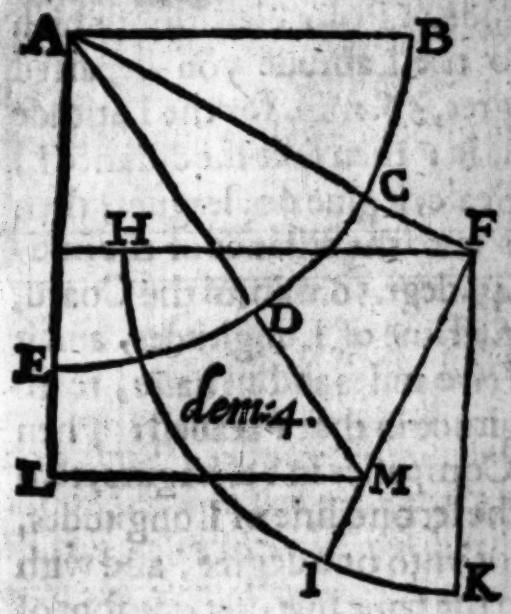
is

is the destance of the course that the second Ship made from the North Westward, which is found by this demonstration to be North West, and by North, and three degrees fiue minutes to the Westward.

CHAP. XV.

Two ships departing from one Parallell and Port, in the Parallell of 47. degr. 56. min. the first in sailing 80. leag. bewixt the North and West, hath raised the Pole two degrees, I demaund by what Course the second ship must runne, and how much she shall alter her first Meridian or longitude, to bring herselfe 40. leagues and two miles North and by East, and 41. minutes to the Eastward of the first ship.

IN the fourth Demonstration drawe the Quadrant, A. B. C. D. E. then multiplie your two degrees, you haue altered your Latitude by twenty, and it maketh fourtie Leagues; which fourtie Leagues set vpon the line A. E. L. from A. vnto G. then from the point G. draw the line G. F. parallell vnto A. B. then open your Compasses vnto the distance of 80. Leagues, which are the leagues your first ship did runne, and place one foote of your Compasses in the Center A. and with the other make a marke in the line G. F.



G. F. which will bee at the point F. then from the Center A. vnto the point F. draw the line A. F. repreſenting the diſtance of the courſe of the firſt ſhippe 80. leagues: Then from F. let fall a Pependicular F. K. and vpon the Center F. vpon the Radices of the Scale draw the Arch H. I. K. Then in regard you muſt bring the ſecond ſhip North and by Eaſt, and 41. minutes Eaſtward of the firſt ſhip, take 11. degrees 56. minutes from your Scale of coards, and place them from K. vnto I. vpon the Quadrant K. I. H. Then from F. draw the line I. F, and vpon the line F I, place the diſtance that you muſt bring the ſecond ſhippe from the firſt (which is 40. leagues and two miles) from F. vnto M. So is M. the place of your ſecond ſhip. Then from M. draw the line M. L. parallell vnto F. G. cutting the line A. G, L. in L. then draw the line M, A. cutting the Quadrant B. D, E. in D. So ſhall the Arch D. E. be the courſe that the ſecond ſhip muſt runne, to bring her ſelfe 40. leagues and two miles North and by Eaſt, and 41. minutes Eaſt of the firſt ſhip. Then to know what you haue altered the Latitude, firſt take the diſtance L. A. and apply it vnto the Scale of equall parts, and you ſhall finde it to

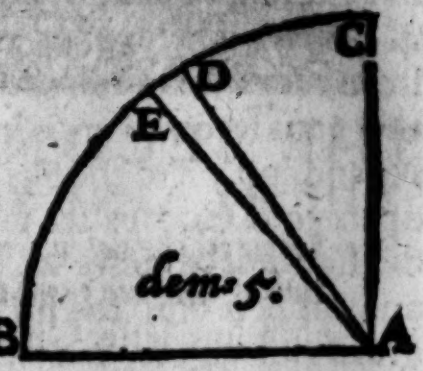
bee 80. leagues, which is iuſt 4. degrees, which you haue altered your Latitude, or Poles Eleuation: which 4. degrees added vnto the Latitude you departed from, it makes 51. degres, 56. min. for the Latitude that your ſecond ſhip is in: then take the diſtance L. M. and apply it to the Scale, it giue 60. leagues; then open your Compaſſes vnto the diſtance of the middle Latitude, which is 49. degr. 56. min. of the Coard, and apply it vnto the firſt line of Longitudes, and it giues 12. Leagues, and two miles and an halfe, to alter one degree of Longitude in that Parallell: Then ſet one foote of your Compaſſes in 12. leagues, two miles and an halfe in the ſecond line of Longitudes, extending the other foot vnto one degree, and with the ſame diſtance vpon the ſame line, ſet one foot of the Compaſſes in 60. leagues (the leagues that you are from the Meridian) and the other foote will extend vnto 4. degr. 40. min. which is the difference of the Longitude.

CHAP. XVI.

To finde by Demonſtration how many miles or minutes of any Parallell, doeth anſwere vnto one Degree of the Equinoctiall.

LEt the Latitude giuen bee 58. degr. 54. min. therefore hauing drawen the Quadrant A. B. C. from B. vpon the Coard B. E. C. ſet the Latitude of the place 58. degrees 54. minutes vnto the point D. Then from

from the point D. drawe the Line D. F. parallell vnto B. A. So ſhall the length of the Line D. F. bee the number of miles, which anſwere vnto one degree of Longitude in the Parallell of 58. degrees 54. minutes, which being applied vnto your Scale of equall parts, giues thirty one miles. So likewiſe the Arke B. E. being the Latitude of 52. degrees, ending in the point E. giue the lines E. F. For the miles that anſwere vnto one degree of Longitude in the Parallell of 52. degrees were found by the Scale to be 36. miles, and 56. Seconds or $\frac{56}{60}$ of a mile.

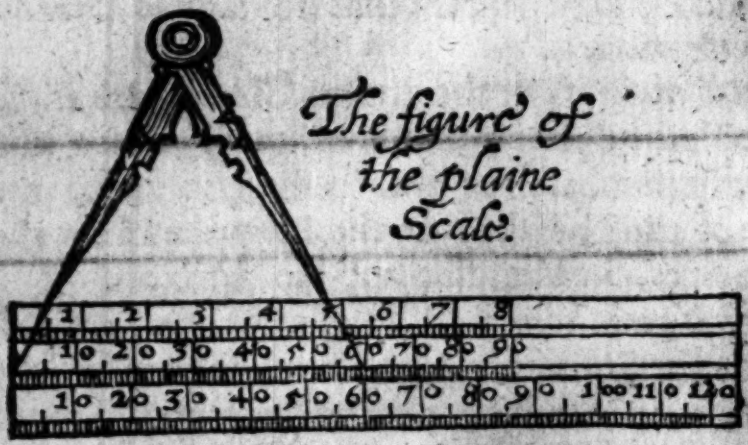


THE SECOND BOOKE OF THE PLAINE SCALE WHEREIN

is declared, the definition of the Spheare, a description of the sixe great Circles, and also of the foure lesser Circles, and last of all, Certaine questions Astrono-*micall performed by the said Scale.*

CHAP. VI.

De Sphæra.



The figure of the plaine Scale.

A Spheare according to the discription of *Theodosius*, is a certaine sollid Superficies, in whose middle is a Point, from which all Lines drawn vnto the Circumference are equall; which Point is called the Center of

of the Spheare, by which Center a right Line being drawne, and extending himselfe on either side vnto that part of the Circumference whereupon the Spheare is turned, is called *Axis Sphæræ*, or the Axeltree of the world.

A Spheare accidentally, is diuided into two parts, that is to say, *in Sphæram rectam, & Sphæram obliquam.*

Sphæra recta, or a right Spheare, is onely vnto those that dwell vnder the Equinoctiall, *Quibus neuter Polorum magis altero eleuatur*: that is, to whom neither of the Poles of the world are seene, but lie hid in the Horizon.

Sphæra obliqua, or an oblique Spheare: is vnto those that inhabite on either side of the Equinoxiall, vnto whom one of the Poles is euer seene, and the other hid vnder the Horizon.

The Circles whereupon the Spheare is composed, are diuided into two sorts: that is to say, *in Circulos maiores & minores.*

Circuli maiores, or the greater Circles, are those that diuide the Spheare into two equall partes: and they are in number sixe: *viz.* the Equinoctiall, the middle of the Zodiake, or the Ecliptike Line, the two Colures, the Meridian, and the Horizon.

Minores vero Circuli, or the lesser Circles, are such as diuide the Spheare into two parts vnequally: and they are foure in number; as the Tropike of Cancer, the Tropike of Capricorne: the Circle Artike, and the Circle Antartike.

CHAP. II.

Of the foure greater Circles.

THE Equinoctiall is a Circle that crosseth the Poles of the world at right Angles and diuideth the Sphearе into two equall parts, & is called the Equinoctiall, becauſe when the Sunne commeth vnto it, (which is twice in the yeere, *viz. In principio Arietis, & libræ*, that is, in March and September) the dayes and nights are equall thorowout the whole world. whereupon it is called *Equator diei & noctis*, the equall proportioner of the day and night artificiall: and in the figure is deſcribed by the Line C. A. E.

The Meridian is a great Circle, paſſing through the Poles of the world, and the Poles of the Horizon, or Zenith point ouer our heads, and is ſo called, becauſe that in any time of the yeere, or in any place of the world, when the Sunne (by the motion of the heauens) commeth vnto that Circle, it is noone or twelue of the Clocke. And it is to bee vnderſtood, that all townes and places that lie East and Weſt one of another, haue euery one a ſeuerall Meridian: but all places that lie North and South one of another, haue one and the ſame Meridian. This Circle is declared in the figure following by the Circle B. C. D. E.

The Horizon is a Circle, diuiding the ſuperiour Hemiſpheare from the inferiour, whereupon it is called

called Horizon, that is to ſay, the bonds of ſight, or the farthest diſtance that the eie can ſee, and therefore it is alſo called *Circulus Hemiſphæri.* The Horizons are diuided into two ſorts, *viz. rectus & obliquus*, a right and an oblique, or a declining Horizon: whereof thoſe haue a right Horizon which haue the Equinoctiall for their Zenith, and the Poles of the world in their Horizon: becauſe the Horizon (hiding both the Poles of the world) is a Circle ſuppoſed to bee drawne by the Poles of the world, diuiding the Equinoctiall at right Angles, as in the figure following you may plainely ſee. Firſt imagining the Circle X. V. Y. W. to be the earth, and thoſe that inhabite at the Point V. haue the Line B.D. for their Horizon, cutting the Equinoctiall C. A. E. at right Angles in A. and therefore is called Horizon *rectus, & Sphæra recta*, a right Horizon, and a right Spheare. Thoſe haue an oblique Spheare, or an oblique Horizon to whom one of the Poles are viſuall, or eleuated aboue the Horizon, and haue the other hid vnder the Horizon, and in regard ſuch a Horizon doth croſſe the Equinoctiall at oblique Angles: it is called Horizon *obliquus*, or a declining Horizon, as for example: Thoſe that inhabit at the point S. haue T. for their Zenith, and K. A. L. for their Horizon, diuiding the Equinoctiall C. A. E. at oblique Angles, making the Angle contained betwixt the Horizon A. K. and the Equinoctiall A. C. an Angle of thirty eight degrees, and twenty eight minutes, and the Angle contained betwixt the Horizon A. L. and the Pole A. D. an Angle of 51. degrees, thirty two minutes, which is the eleuation of the Pole for thoſe that inhabite at S. thoſe and all other haue an oblique Spheare, except they

they inhabite iust vnder the Equinoctiall Circle, vnto whom onely doth a right Spheare belong.

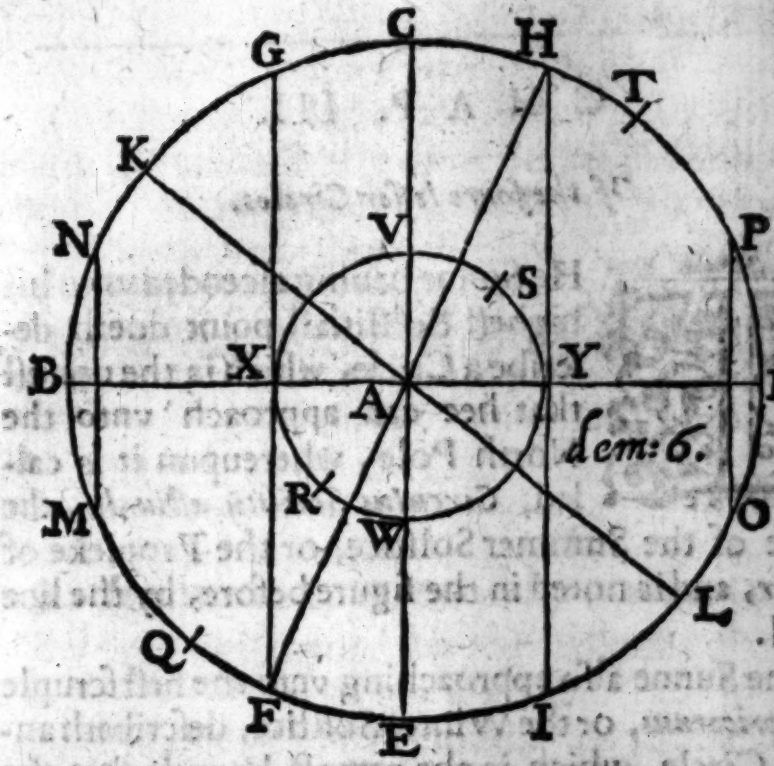
Colurus Solstitiorum, or the Summer Colure is a Circle passing by the Poles of the world, and by the Poles of the Eccliptique, and by the head of Cancer and Capricorne, where vpon the first scruple of Cancer where the Colure crosseth the Eccliptique Line, is called *Punctus Solstitiæ æstivalis*, or the point of the Summer Solstice: to which place when the Sunne commeth, hee can approach no neerer vnto our Zenith, but returneth vnto the Equator againe. *Arcus vero Coluri*, The Arke of the Colure contained betwixt the Summer Solstice and the Equator, is called the greatest declinatiō of the Sun, which *Ptolemie* found to be 23. degrees 31. minutes: but by the obseruation of *Copernicus* it was found to vary, for hee found the declination sometimes to bee 23. degrees 52. minutes, and in processe of time, to bee but 23. degrees 28. minutes. And in these our daies (by the obseruation of *Ticho de Brahe*, and that late famous Mathematitian, Master *Edward Wright*) it is found distant from the Equinoctiall 23. degrees, 31. min. 30. seconds.

The other Colure passeth by the Poles of the world, and by the first Point of *Aries* and *Libra*, whereupon it is called, *Colurus distinguens Equinoxia*. These two Colures doe crosse each other at right Angles in the Poles of the world, whereupon these verses were made.

Hæc duo Solstitia faciunt Cancer Capricornus,
Sed noctes æquant Aries & Libra diebus.

The

The Zodiake is another of the greater Circles, diuiding the Equinoctiall into two equall parts, by the head of *Aries*, & *Libra* the one half of it, doth decline



vnto the North and the other into the South, the greatest of which declination is three & twenty degrees, one and thirty minutes, and thirty seconds. Note also, this Circle is diuided into twelue equall parts, which partes are attributed vnto the twelue Signes, *Aries* ♈. *Taurus* ♉. *Gemine* ♊. *Cancer* ♋. *Leo* ♌. *Virgo* ♍. *Libra* ♎. *Scorpio* ♏. *Sagitarius* ♐. *Capricornus* ♑. *Aquarius* ♒, and *Pisces* ♓. And euery one of these Signes are diuided into 30. equall parts, which which are called degrees, so the whole Zodiake containeth one hundred and sixty degrees. Likewise, euery degrees is diuided into sixty equall parts, which

parts are called minutes, and are in number 21600. minutes, and as 21600. minutes is the whole circumference of the Heauens, so is 21600 miles the whole circuit of the Earth.

CHAP. III.

Of the foure lesser Circles.

THe Sunne hauing ascended vnto his highest Solstitiall point doeth describe a Circle, which is the neerest that hee can approach vnto the North Pole, whereupon it is called, *Circulus Solstitij æstiualis*, the Circle of the Summer Solstice, or the Tropicke of *Cancer*, and is noted in the figure before, by the line H.Y.I.

The Sunne also approaching vnto the first scruple of *Capricornus*, or the Winter Solstice, describeth another Circle, which is the vtmost bounds that the Sunne can depart from the Equinoctiall line towards the Antarticke Pole, whereupon it is called, *Circulus solstitij hyemalis, siue Tropicus hyemalis, vel, Capricornij*: the Circle of the Winter Solstice, the Winter Tropicke, or the Tropicke of *Capricorne*, and is described in the figure by the line G.X F.

So much as the Eclipticke declineth from the Equinoctiall, so much doeth the Poles of the Eclipticke, decline from the Poles of the world, whereupon the Pole of the Eclipticke, which is by the North Pole of the world, describeth a certaine Circle as it passeth

passeth about the Pole of the world, being iust so farre from the Pole as the Tropicke of *Cancer* is from the Equator, and it is the third of the Lesser Circles, and is called, *Circulus Arcticus*, or the Circle of the North Pole, and is described in the Diagram, in the second Chapter by the line P. O.

The fourth and last of the lesser Circles, is described in like maner, by the other Pole of the Ecliptick, about the South Pole of the world, and therefore called, *Circulus Antarcticus*, the Antarcticke Circle, or the Circle of the Antarcticke or South Pole, and is demonstrated in the former figure, by the line N. M.

Certaine questions Astronomicall, performed by the plaine Scale.

CHAP. IIII.

The true place of the Sunne, giuen to finde his declination.

THe Sunne being in the head of *Taurus*, his declination is desired: By the seuenth Demonstration, draw the line A. D. then vpon the Center A. raise the Perpendicular A. B. then opening your Compasses to the Radius of your Scale, and place one foote in the

Center A. and with the other draw the Quadrant B. C. D. then opening your Compasses vnto the greatest declination of the Sunne, and place it vpon the Quadrant from D. vnto K. then from the point K. draw the line K. H. cutting the line A. B. in H. then with the distance A. H. draw the small Quadrant G. E. H. and in regard the Sun is in the head of *Taurus* which is 30. degrees from the beginning of *Aries*, let A. D. be the Equator, & D. the beginning of *Aries* D. C. 30. degrees, or Longitude of the Sunne, then from the point C. draw the line C. A. cutting the Quadrant G. E. H. in E. then from E. draw the line E. L. parallell to A. D. cutting the Quadrant B. C. D. in L. so shall the Arch L. D. bee the declination of the Sunne desired, which in this demonstration is found to bee eleuen degrees and thirtie one minutes.

CHAP. V.

The Declination of the Sunne, and quarter of the Eclipse that he possesseth, being giuen, it is desired to finde his true place.

The Declination is 10. *degr.* 31. *min. the first quarter that hee possesseth, is betwixt the head of* Aries *and Cancer.*

FIrst, by the seuenth Demonstration, draw the Quadrant A. B. C. D. as is taught in the former Chapter, then set the greatest declination of the Sunne vpon the Coard from D. vnto K. which is 23. degr. and 31. min. then from K. draw the line K. H. parallell vnto the *Equator* D. A. cutting the line B. A. in the point H. So shall H. A. bee the signe of the Sunnes greatest declination, then with the distance A. H. draw the Circle G. E. H. then from D. vpon the Coard, D. C. B. set the declination of the Sunne, which is 11. degrees 31. minutes from D. vnto L. then draw e the line L. E. parallell vnto A. D. cutting the Quadrant G. E. H. in E. Then from the Center A. by the point E. draw the line A. E. C. cutting the Quadrant B. C. D. in C. So shall the Arke C. D. bee the distances of the Sunne from the head of *Aries*, which is here found to be iust thirty degrees, which is in the beginning of *Taurus*.

CHAP. VI.

By the Eleuation of the Pole, and declination of the Sunne, to finde the Amplitude of the Sunne, or his true rising, or setting from the East or West point.

BY the eight Demonstration, first drawe the line B. D. then vpon the Center A, draw the Circle B. C. D. E. then from A. raise the Perpendicular C. A. E. then is your Circle diuided into foure equall parts: then suppose the Eleuation of the Pole to be 51. degrees, 32. minutes, which must bee placed vpon the Circle, from D. vnto F. then from the point F. by the Center A. draw the line F. A. G. representing the Pole of the world F. being the North Pole, and G. the South Pole, then substract 51. degr. 32. min. from 90. degr. and the remainder is the height of the Equinoctiall, which is 38. degr. 28. min. which must be placed vpon the Circle from the Horizon B. vnto the point I. then from I. by the Center A. draw the line I. A. H. representing the Equinoctiall Circle. Then from I. vnto M. set the declination of the Sunne, being heere supposed 14. degr. 52. minutes North, then from the point M. draw the line, or parallell of Declination M. T. N. parallell vnto the Equator I. A. H. cutting the Horizon B. D. in T. then from T, raise the Perpendiclar T. V. cutting the Circle B. C. D. E. in V. so shall the distance C. V. bee the true Amplitude of the Sunne desired, which here is found to be 24. degr. 21. minutes North.

CHAP.

CHAP. VII.

By the Amplitude of the Sunne, to finde the Variation of the Compasse.

HAuing found the Amplitude of the Sunne by the last Chapter, first obserue with a Compasse, or rather with a Semicircle vpon what degree and minute the Sunne riseth or setteth, beginning to reckon from the East or West, and ending at the North or South at 90. degrees: and when you haue diligently obserued the Magneticall rising or setting, by the *Semicircle*, or by some other like fitting Instrument: and also the true Amplitude found, as is declared in the last Chapter, the difference of these two Amplitudes, is the variation of the Compasse: But when the Sunne riseth vpon the same Degree of the Compasse, as is found by the Scale, the variation is nothing, but the needle pointeth directly vnto the Poles of the world, which by M^r. *Mulinux* was affirmed to be at the Westernmost part of S^t. *Michaels*, one of the Ilands of the *Azores*, from whence hee will haue the Longitude reckoned. Secondly, when the Sunne is in the Equinoctiall Circle, where hee hath no Amplitude, looke what distance the Compasse maketh the Sunne to rise from the East or West of the Compasse, the same distance is the Compasses variation, from the North or South. Thirdly, if the Sunne rise more to the South of the Compasse, or setteth more

more to the North by the Compasse, then is shewed by the Scale, the difference betwixt the Amplitude giuen by the Scale, and the Amplitude giuen by the Needle, is the variation of the Compasse from the North Westward. Fourthly, if the Compasse sheweth the Sunne to rise more Northward, or set more Southward, then is shewed by the Scale, the difference is the variation of the Compasse, from the North Eastward. Fifthly, if the Scale shew the Amplitude of the Sunne rising Southerly, and the Compasse shew it to bee Northerly, adde both the Amplitudes together, and they shew you the variation Westernly.

CHAP. VIII.

The place of the Sunne being giuen to finde his declination by a whole Circle.

According vnto the right Demonstration, first draw the Circle B. C. D. F. then draw the Horizon. B. A. D. and then the Equinoctiall I. A. H. as is before taught: and then the Tropicke of *Cancer* K. L. twenty three degrees and a halfe from the Equinoctiall: then draw the Tropicke of *Capricorne* P. O. of like distance from the Equinoctiall, and after from K. to O. draw the Eccliptique Line K. A. O. And when you haue thus laid downe the Spheare, suppose the Sunne to be in the tenth degree of *Taurus*, at which time his declination is desired. And in regard the

Sunn

Sunne is more neerer vnto the Tropicall point *Cancer*, then vnto *Capricorne*; first find how many degrees hee is from the Tropicke of *Cancer*, and you shall find him to be fifty degrees; therefore take with your Compasses fifty degrees from the Corde, and apply it from the Tropicall point *Cancer* at K. vnto V. vpon one side and vnto P. on the other side: then draw the Line V. P. cutting the Ecclipticke K. O. in the point R. then from R. draw the Line M. R. N. parallell vnto the Equinoctiall I. A. H. and cutting the Quadrant B. C. in the point M. So shall the Arke M. I. be the declination of the Sunne desired, which being applyed vnto your Scale giues you foureteene degrees and fifty two minutes.

CHAP. IX.

The elevation of the Pole, and declination of the Sunne, giuen to find his height in the virticall Circle.

The Pole is elevated 51. degrees 32. minutes, the declination of the Sunne is 14. degrees 52. minutes North, his hieght in the virticall Circle is found as followeth.

FIrst according vnto the former chapter, draw the Circle B. C. D. E. then the Horizon B. A. D. and after the Virticall Line C. A. E. then the Pole of the world F. G. and likewise the Equator I. A. H. this being done,

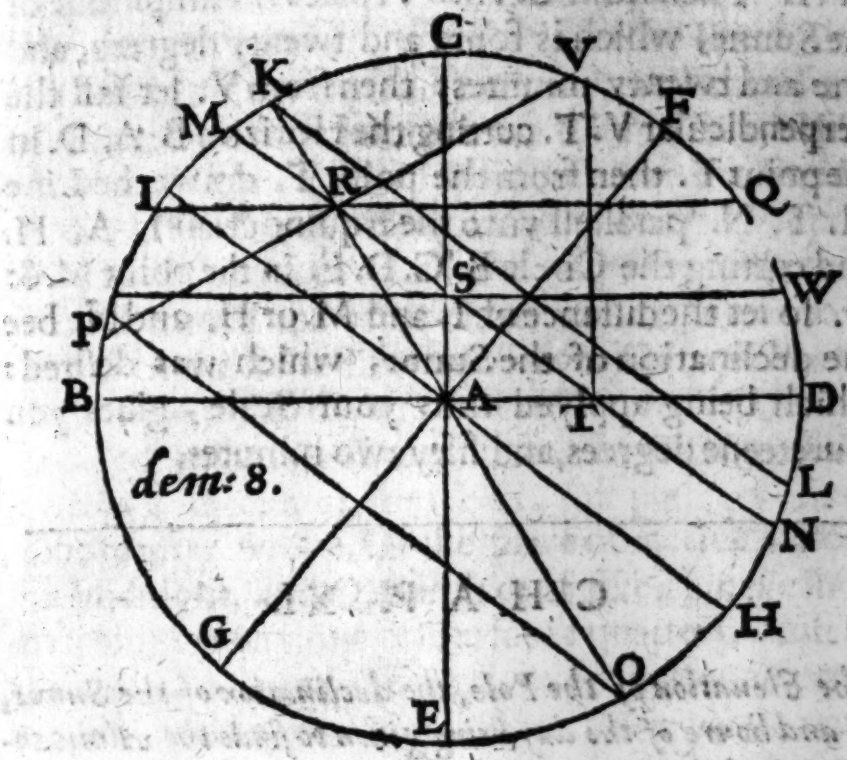
place the declination of the Sunne 14. degrees 52. minutes, vpon the Circle from I. vnto M. and also from H. vnto N. then draw the Line M. N. cutting the Line C. A. E. in S. then from S. draw the Line S. W. parallell vnto the Horizon B. A. D. cutting the Meridian Circle B. C. D. E. in W. So shall the distance D. W. be the height of the Sunne in the verticall Circle, for the time demanded, which by this proposition is found to be nineteene degrees and eight minutes.

CHAP. X.

The eleuation of the Pole, and the amplitude of the Sun, being giuen, to find the declination.

The eleuation of the Pole is 51. degrees 32. minutes, the Sunnes Amplitude is 24. degrees 21. minutes, the declination is found as followeth by the eigth demonstration.

First



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FIrſt vpon the Center A. draw the Circle B. C. D. E. then drawe the Line B. A. D. repreſenting the Horizon: diuiding the Circle into two equall parts, then draw the Line C. A. E. Perpendicular to B. A. D. repreſenting the Eaſt and Weſt point of the Compaſſe, then placing the eleuation of the Pole fifty one degrees, and thirty two minutes, from D. vnto F. from F. by the Center A. draw the Line F. A. G. which let be the Pole or Axeltree of the world, then from B. vnto I. and from D. vnto H. ſet the complement of the Poles eleuation: which ſhall repreſent the Equinoctiall, in regard it maketh right Angles with the Pole of the world, in the Cen-

ter A. Then from C. vnto V. place the amplitude of the Sunne, which is foure and twenty degrees, and one and twenty minutes: then from V. let fall the Perpendicular V. T. cutting the Horizon B. A. D. in the point T. then from the point T. drawe the Line M. T. N. parallell vnto the Equinoctiall I. A. H. and cutting the Circle B. C. D. E. in the point M. & N. so let the distance of I. and M. or H. and N. bee the declination of the Sunne, which was desired: which being applyed vnto your Scale, giues you foureteene degrees, and fifty two minutes.

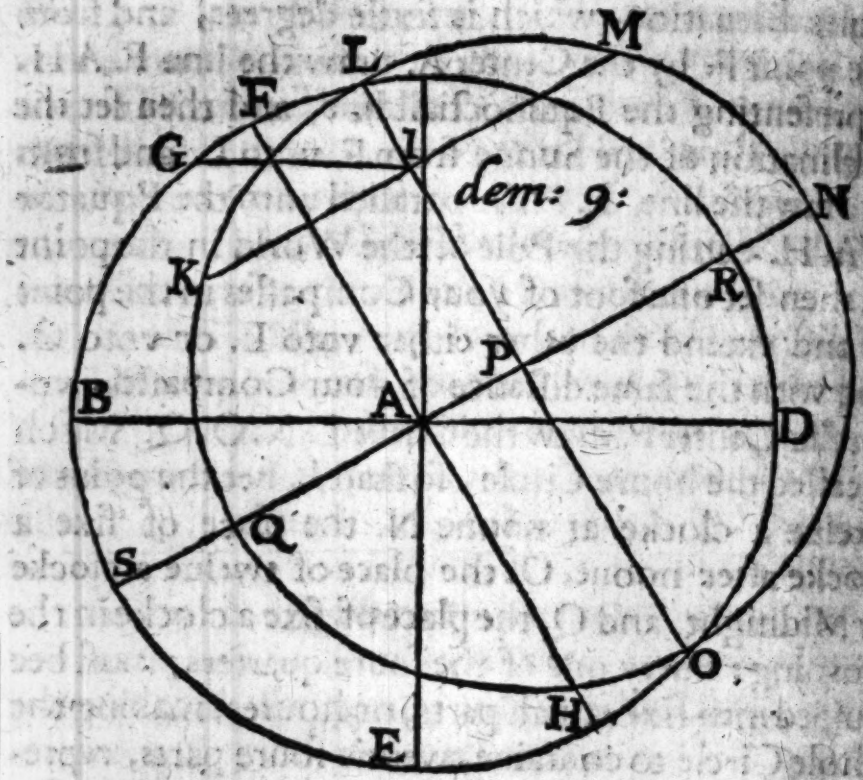
CHAP. XI.

The Eleuation of the Pole, the declination of the Sunne, and houre of the day being giuen to finde the Almicanter is desired.

The Eleuation of the Pole is thirtie degrees, the declination of the Sunne is twentie degrees North, the houre is nine in the morning, at which time the Almicanter is found, as followeth.

BY the ninth demonstration, first vpon the Center A. draw the Circle B. C. D. E. then draw the line B. D. for the Horizon, then place your Poles Eleuation which is thirtie degrees, vpon the circle from D. vnto R. then from R. by the Center A. draw the line R. A. S. representing the Pole of the World, then from B. vnto F. place the Complement of the Poles

Poles Eleuation, which is ſixtie degrees, and from the point F. by the Center A. draw the line F. A H. repreſenting the Equinoctiall line, and then ſet the declination of the Sunne from F. vnto L. and from L. draw the line. L. P. O. parallell vnto the Equator F. A. H. cutting the Pole of the World in the point P. then ſet one foot of your Compaſſes in the point P. and extend the other either vnto L. or vnto O. and with the ſame diſtance of your Compaſſes, vpon the Center P. draw the Circle L. N. O. Q. which is called the houre Circle, ſo ſhall L. bee the point of twelue a clocke at noone N. the place of ſixe a clocke after noone, O. the place of twelue a clocke or Midnight, and Q. the place of ſixe a clocke in the morning: Euery one of the foure quarters, muſt bee diuided into ſixe equall parts, or houres, making the whole Circle to containe twentie foure parts, repreſenting the twentie foure houres of the day, & night, then in regard the houre of the day was nine of the clocke, which is three houre before noone, take three of thoſe twentie foure houres, and place them vpon the Circle L. N. O. Q. from the Meridian point L. vnto K. the nine a clocke point in the morning, and vnto M. the point of three a clocke after noone, then draw the line M. K. cutting the parallell of the Sunne L. O. in the point I. then from I. draw the line I. G. parallell vnto the Horizon B. A. D. which ſhall cut the Meridian Circle B. C. D. E. in the point G. ſo let the diſtance of G. and B. bee the Almicanter of the Sunne which was deſired, which in this demonſtration is found to bee fortie eight degrees and eighteene minutes.



CHAP. XII.

The Eleuation of the Pole, the Almicanter, and declination of the Sunne, being giuen to finde the houre of the day.

The Eleuation of the Pole is thirtie degrees, the declination of the Sunne is twentie degrees, the Almicanter of the Sunne is fortie eight degrees and eighteene minutes, the houre of the day is found as followeth, by the ninth Demonstration.

FIrst vpon the Center A. draw the circle B. C. D. E. then draw the Diameter B. D. representing the Horizon, then from D. vnto R. set thirtie degrees, the Eleuation of the Pole, then from R. by

by the point A. draw the line R. A. S. repreſenting the Pole of World, then draw the line F. A. H. croſſing the Pole in A. at right Angles, cutting the Meridian line in F. then from F. ſet twentie degrees, the declination of the Sunne vnto L. and then from the point L. draw the line L. P. O. repreſenting the parallell of the Sunne, and cutting the Pole of the world in P. then placing one foote of your Compaſſes in P. extend the other vnto L. with which diſtance of your Compaſſes, draw the houre Circle L. N. O. Q. then from the Horizon at B. place the Sunnes Almicanter: (which is fortie eight degrees and eighteene minutes,) vpon the Quadrant B. G. L. from B. vnto G. then from the point G. draw the line G. I. parallell vnto the Horizon B. A. D. cutting the line L. O. in I. then from the point I. draw the line K. I. M. parallell to the Pole of the world. Q. A. N. cutting the Circle L. N. O. in M. then let L. N. bee diuided into ſixe houres, whereof L. M. are three: whereupon I conclude, that it is three howres from noone, that is, at nine a clocke in the morning, or three in the after noone.

CHAP.

CHAP. XIII.

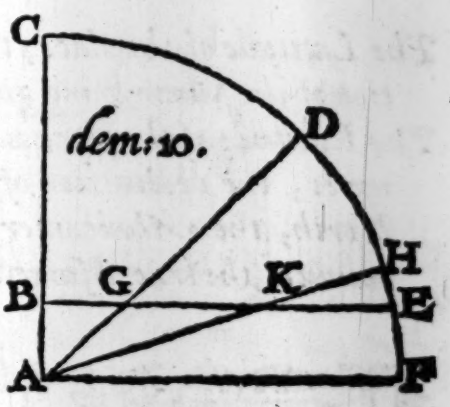
The Almicanter, or height of the Sunne being giuen, to finde the length of the right shaddow.

ACcording vnto the tenth Diagram, draw the line A. F. and vpon the Center A. raise the Perpendicular A. C. then vpon the Center A. draw the Quadrant C. D. F. then suppose the hight of your Gnomon, or substance yelding shaddow be the line A. B. which is to be diuided into twelue equall parts, which Gnomon I haue here made iust twelue degrees of the equall League of the Scale, then from B. to the top of the Gnomon, draw the line B. E. parallell vnto A. F. then set the Almicanter which is fortie fiue degrees from F. vnto D. and from the point D. draw the line D. A. cutting the line B. E. in the point G. so shall B. G. bee the length of the right shaddow desired, which here is found to bee foureteene degrees and eighteene minutes, which is but iust the length of your Gnomon, and $\frac{2.}{12.}$ and $\frac{1.}{3.}$ of a twelfe ouer: Note that the right shaddow, is the shaddow of any post, staffe, or steeple, that stãdeth at right angles with the Horizon, the one end thereof respecting the Zenith of the place, and other the *Nadir*.

CHAP.

CHAP. XIIII.

The Almicanter, or height of the Sunne being giuen, to finde the length of the contrary ſhaddow.



BY the verſe or contrary ſhaddow, is vnderſtood the length of any ſhaddow, that is made by a ſtaffe or Gnomon, ſtanding againſt any Perpendicular wall, in ſuch a maner that it may lie parallell vnto the Horizon, the length of the contrary ſhaddow, doeth increaſe as the Sunne riſeth in height: whereas contrariwiſe the right ſhaddow doeth decreaſe in length, as the Sunne doeth increaſe in height: the way to finde the verſe ſhaddow is as followeth. Firſt draw your Quadrant as is taught in the laſt Chapter, wherein let A. B. be the length of the Gnomon, likewiſe from B. draw the line B. E. parallell vnto A. F. as before, then ſet your Almicanter from C. vpon the Quadrant which is giuen to be ſeuentie degrees, and it will extend from C. vnto H. then from the point H. draw the line H. A. cutting the line B. E. in the point K. ſo ſhall K. B. bee the length of the contrary

ſhaddow, which here is found to bee thirtie foure degrees and eight minutes, or twice ſo long as your Gnomon, and $\frac{10.}{12.}$ and about $\frac{1.}{8.}$ part of a twelft more.

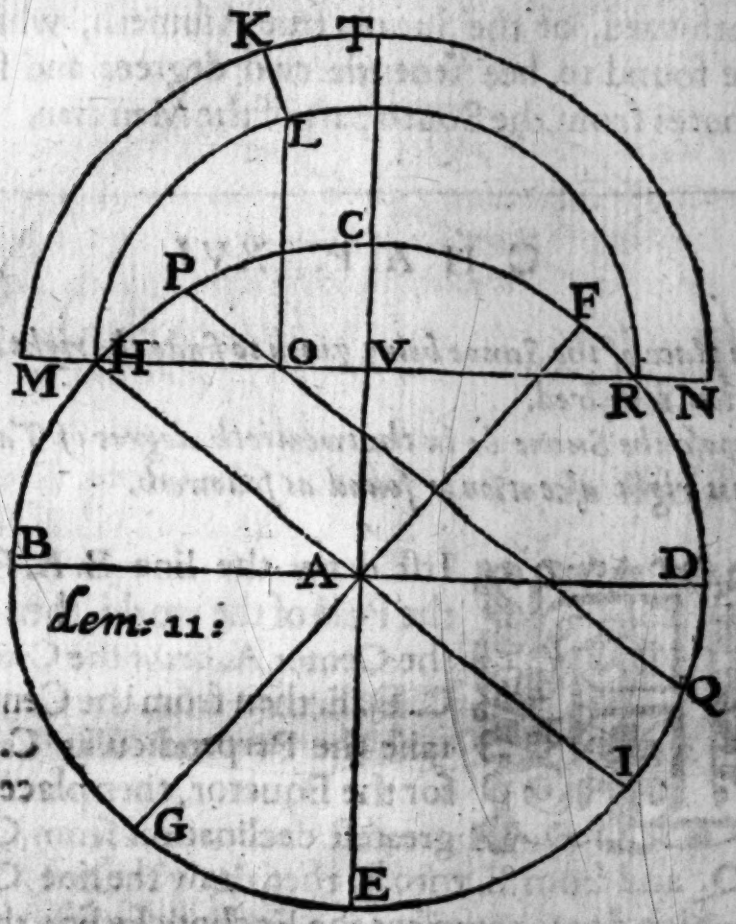
CHAP. XV.

The Latitude of the place, the Almicanter, and declination of the Sunne being giuen, to finde the Aſumeth.

The Latitude of the place is fiftie one degrees thirtie minutes, the declination of the Sunne twentie degrees North, the Almicanter thirtie eight degrees thirtie minutes, the true Aſumeth of the Sunne is deſired.

FIrſt vpon the Center A. draw the Circle B. C. D. E. then draw the Diameter B. A. D. and from D. vnto F. ſet the Eleuation of the Pole, which is one and fiftie degrees and thirtie minutes, whoſe complement is eight and thirtie degrees and thirtie minutes, which muſt bee placed from B. vnto H. then from H. draw the line H. A. I. repreſenting the Equinoctiall line, and from F. draw the line F. A. G. repreſenting the Pole of the World, then from H. vnto P. and from I. vnto Q. ſet the declination of the Sunne, which is twentie degrees, and by thoſe two points draw the line P. Q. for the parallell

parallell of the Sunnes declination; then vpon the Circle from B. vnto H. ſet the Sunnes Almicanter, thirtie eight degrees and thirtie minutes, then from H. draw the line H. R. parallell vnto the Horizon cutting the Sunnes parallell P. O. Q. in O. then draw the line T. V. A. E. Perpendicular vnto the



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line B. A. D. in the Center A. and cutting the line H. V. R. in V. then ſet one foote of your Compaſſes in the point V. extend the other vnto R. and with the ſame diſtance draw the Semicircle H. L. R. then draw the Concentricke Circle vpon the Radius of

the Scale M. T. N. and where the line P. O. Q. and and the line M. O. N. doe meete in the point O. raiſe the Perpendiclar O. L. cutting the Semicircle H. L. R. in L. then lay the Scale from the Center V. to the point L. and draw the line L. K. cutting the Semicircle M. T. N. in K. ſo ſhall K. T. bee the true diſtance of the Sunne, from the Eaſt, or Weſt point Southward, or the Sunnes true Aſumeth, which is here found to bee ſeuentie two degrees and fortie minutes from the South part of the Meridian.

CHAP. XVI.

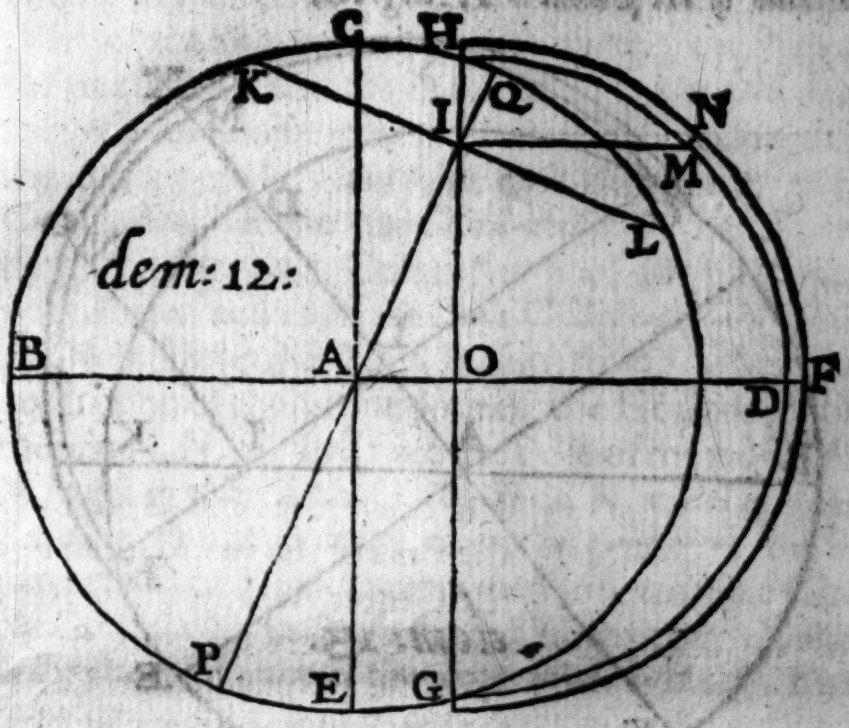
The place of the Sunne being giuen to finde the right aſcention, is deſired.

Suppoſe the Sunne be in the twentieth degree of Taurus, his right aſcention is found as followeth.

FIrſt draw the line B. A. F. for the Pole of the world, then vpon the Center A. draw the Circle B. C. D. E. then from the Center A. raiſe the Perpendicular C. A. E. for the Equator, then place your greateſt declination from C. vnto Q. and from E. vnto P. then draw the line Q. A. P. which doeth repreſent the Eccliptick line, then in regard the Sunne is in the twentieth degree of *Taurus*, which is fortie degrees from the head of *Cancer*, which fortie degrees place from Q. vnto L. and vnto K. then draw the line K. L. cutting the Eccliptick in I. then from the point I. draw the line H. I. parallell

vnto

vnto C. A. E. cutting the Pole of the World in O. then set one foote of your Compasses in O. and extend the other vnto G. with which distance draw the Semicircle H. D. G. then opening your Compasses vnto the Radius of the Scale, and vpon the Center O. likewise draw the Circle H. N. F. G. then draw the line I. M. parallell vnto A. O. D. cutting the Se-

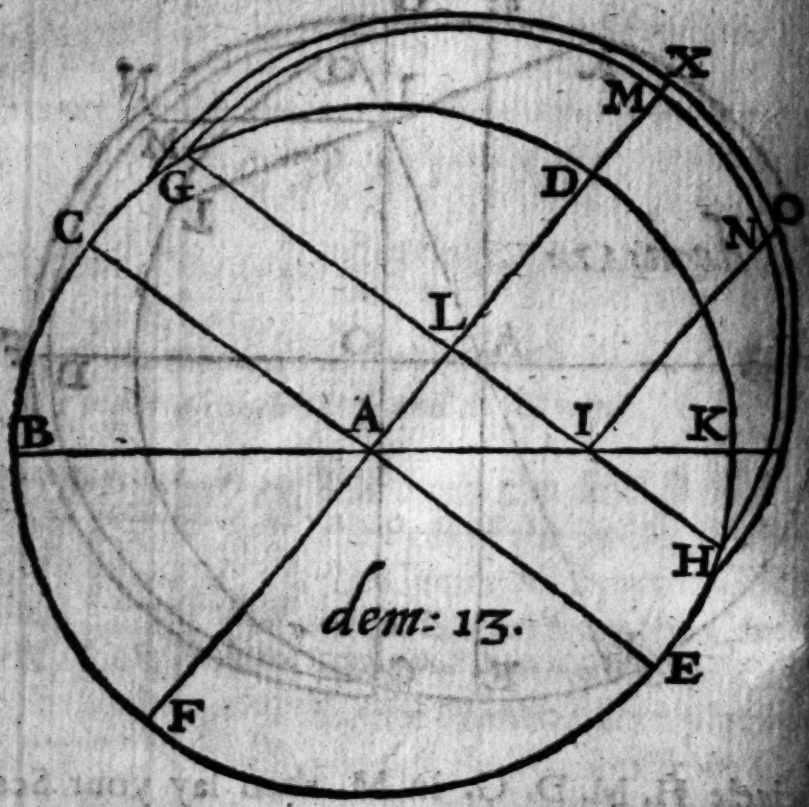


micircle H. M. D. G. in M. then lay your Scale from the Center O. vnto the point M. and draw the line N. M. cutting the Concentricke Circle in N. so shall the distance N. F. be the right ascention, which is here found to bee two and fortie degrees seuen and twentie minutes.

CHAP. XVII.

The eleuation of the Pole, and declination of the Sunne, giuen to find the difference of the aſcenſions.

The Poles eleuation is 51. *degrees* 32. *minutes, the declination of the Sunne is* 21. *degrees.*



FIrſt draw the Line B. A. K. repreſenting the Horizon, then vpon the Center A. drawe the Circle B. C. D. E. F. Then from K. vnto D. ſet the eleuation of the Pole, which is one and fifty degrees, and thirty two

two minutes: then from the point D. by the Center A. draw the Line D. A. F. representing the Pole of the world: then from B. vnto C. set the complement of the Poles eleuation which is thirty eight degrees, and 28. minutes: then from C. by the Center A. draw the Line C. A. E. representing the Equinoctiall Line; then from C. vnto G. and likewise from E. vnto H. set the declination of the Sunne, which is one and twenty degrees, then from G. vnto H. draw the parallell of the Sunnes declination, cutting the Pole of the world in L. and the Horizon in I. then set one foot of your Compasses in the Point L. and extende the other vnto G. then with that distance of your Compasses, drawe the Semi-circle G. M. N. H. then opening your Compasses vnto the Radius of your Scale, and vpon the same Center draw a Concentricke Circle, G X. O. H. then from I. where the declination of the Sunne doth cut the Horizon, draw the Line I. N. parallell vnto the Pole of the world A. M. cutting the Circle G. M. H. in N. then lay your Ruler from the point I. vnto the point N. and so draw the Line N. O. cutting the Concentricke Circle G. X. O. H. in O. so shall the distance of O. and X. be the difference of the ascentions, which is here found to be eight and twenty degrees, and foure and fifty minutes.

CHAP.

CHAP. XVIII.

The right ascension of the Sunne or Starre being given, together with the difference of their ascensions, to finde the oblique ascension.

THe right ascension of any point of the heauens being knowen, the difference of the ascension is either to bee added thereunto, or else to bee substracted from it, according as the Starre is situate in the Northerne or Southerne signes: As for example, if the Sunne be in any of these sixe Signes, *Aries*, *Taurus*, *Gemini*, *Cancer*, *Leo*, or *Virgo*, then the difference of the ascensions is to bee substracted from the right ascension, and the remainder is the oblique ascension. Suppose therefore the Sunne to bee in the fourth degree of *Gemini*, where the right ascension is found to be foure houres, and 8. minutes or 62. degrees and the difference of ascension where the Pole is eleuated 51. degrees, is found to be one houre, 53. minutes otherwise, 28. degrees, 53. minutes: which being taken from the right ascension, leaues two houres, and 16. minutes, or 33. degrees and 42. minutes, which is the oblique ascension of the Sunne in the fourth degree of *Gemini*. But if the Sunne be vpon the South side of the Equinoctiall, either in *Libra*, *Scorpio*, *Sagitarius*, *Capricornus*, *Aquarius*, or *Pisces*, then the difference of the ascensions is to be added vnto the right ascension, and the Product will bee the oblique ascension

aſcenſion. Suppoſe the fourth degree of *Sagitarius*, is giuen, for which Signe and Degree the oblique aſcenſion of the *S*unne is deſired, his right aſcenſion being then found to be 242. degrees, or 16. houres, 8. min. the difference of the aſcenſions is one houre, 53. minutes, or 28. degrees, 18. minutes: which being added vnto the right aſcenſion, makes 18. houres, and one minute; or in degrees 270. degrees, and 18. minutes: which is the oblique aſcenſion of the Sunne, when he is in the fourth degree of *Sagitarius*. And if you would finde the oblique deſcenſion, you muſt adde the difference of the aſcenſions vnto the right aſcenſion, when the Sunne is theſe ſixe Signes, *Aries, Taurus, Gemini, Cancer, Leo, Virgo:* and contrariwiſe, when the Sunne is in the other ſixe *S*ignes, you muſt ſubſtract the difference from the right aſcenſiō, and you ſhall haue the oblique deſcenſion of the Sun, or any *S*tarre, whoſe right aſcenſion and difference of aſcenſions is knowen. But it is to be vnderſtood, that this maner of operations doeth ſerue no longer then you are vpon the North ſide of the Equinoctiall. For if the *S*outh Pole be eleuated, the worke is contrary: for ſo long as the *S*unne is in any of the Northerne Signes, the difference of aſcenſions is to bee added vnto the right aſcenſion, to finde the oblique aſcenſion: And contrariwiſe, ſubſtracted, to finde the oblique deſcenſion. Likewiſe, if the Sunne or *S*tarre be in the Southerne Signes, then is the difference of aſcenſions, ſubſtracted from the right aſcenſion, to finde the oblique aſcenſion, and added, to finde the oblique deſcenſion.

A DESCRIPTION OF SOME PECVLIAR THINGES,

fit to bee conſidered, by ſuch as intend to practiſe the Art of Nauigation, *or Aſtronomy.*

THe Zenith is an immaginary point in the heauens, ouer our heades, making right Angles with the Horizon, as the Equinoctiall maketh with the Pole.

The Nadir is a pricke in the heauens vnder our feet, making right Angles with the Horizon vnder the earth, as the Zenith doth aboue; and therefore is oppoſite vnto the Zenith.

The declination of the Sunne, is the Arke of a Circle contained betwixt the Ecliptique and the Equinoctiall, making right Angles with the Equinoctiall. But the declination of a Starre, is the Arke of a Circle let fall from the Center of a Starre, Perpendicularly vnto the Equinoctiall.

The Latitude is the Arke of a Circle contained betwixt the Center of any Starre, and the Ecliptique Line, making right Angles with the Ecliptique, and counted either Northward, or Southward, according to the Situation of the Starre, whether it bee neerer vnto the North or South Pole of the Ecliptique.

The Latitude of a Towne or country, is the height of the Pole aboue the Horizon, or the diſtance betwixt the Zenith and the Equinoctiall.

The

The Longitude of a Starre, is that part of the Ecliptique which is contained betwixt the Stars place in the Ecliptique, and the beginning of *Aries*, counting them from *Aries* according to the ſucceſſion or order of the Signes.

The Longitude of a Towne or Countrey are the number of degrees, which are contained in the Equinoctiall, betwixt the Meridian that paſſeth ouer the Iles of *Azores* (from whence the beginning of Longitude is accounted) Eaſtwardes, and the Meridian that paſſeth ouer the Towne or Countrey deſired.

The Altitude of the Sunne or Starre, is the Arch of a Circle contained betwixt the Center of the Sun, or any Starre, and the Horizon.

The Amplitude is that part of the Horizon which is betwixt the two Eaſt or Weſt points, and the point of the Compaſſe that the Sunne or any Starre doth riſe or ſet vpon.

Azimuthes are Circles, which meet together in the Zenith, and Croſſe the Horizon at right Angles and ſerue to find the pointe of the Compaſſe, which the Sunne is vpon at any houre of the day, or the Aſumeth of the Sunne or Starre, is a part of the Horizon contained betwixt the true Eaſt or Weſt point, & that Azimuthe which paſſeth by the Center of the ſame Starre to the Horizon.

The right aſcention of a Starre, is that part of the Equinoctiall that riſeth or ſetteth with the Starre, in a right Spheare, or in an oblique Spheare, it is that portion of the Equinoctiall, contained betwixt the beginning of *Aries*, and that place of the Equinoctiall, which paſſeth by the Meridian with the Center of the Starre.

The oblique ascention is a part of the Equinoctiall, contained betwixt the beginning of *Aries*, and that part of the Equinoctiall that riseth with the Center of a Starre, in an oblique Spheare.

The difference ascensionall, is the difference betwixt the right and oblique ascention: or it is the number of degrees contained betwixt that place of the Equinoctiall, that riseth with a Center of a Star, and that place of the Equinoctiall that commeth vnto the Meridian with the Center of the same Starre.

Almicanterahs, are Circles drawne parallell vnto the Horizon, one ouer another vntill you come vnto the Zenith: these are Circles that doe measure the eleuation of the Pole, or height of the Sun, Moone, or Starres aboue the Horizon, which is called the Almicanter of the Sunne, Moone or Star: the Arke of the Sunne or Stars Almicanter, is a portion of an Azimuthe contained betwixt that Almicãter which passeth through the Center of the Starre, and the Horizon.

A generall table for the tides in all places.

The Moones age.	Houres and minutes to be added.		The Moones age.	Houres and minutes to be added.	
Dayes.	Degrees.	Minutes.	Dayes.	Degrees.	Minutes.
1	0.	48	16	0.	48
2	1.	36	17	1.	36
3	2.	24	18	2.	24
4	3.	12	19	3.	12
5	4.	0	20	4.	0
6	4.	48	21	4.	48
7	5.	36	22	5.	36
8	6.	24	23	6.	24
9	7.	12	24	7.	12
10	8.	0	25	8.	0
11	8.	48	26	8.	48
12	9.	36	27	9.	36
13	10.	24	28	10.	24
14	11.	12	29.	11.	12
15	0.	0	30	0.	0

The vse of the Table of the Tides.

FIrst it is to be vnderstood, that by the swift motion of the first mouer, the Moone and all the rest of the Starres, and planners, are turned about the world in foure and twentie houres, vpon which swift motion of the

the Moone, the dayly motions of the Sea doe depend, which motion of the Sea falleth not out alwayes at one houre, the reason thereof is, because of the swift motion of the Moone, in regard shee goeth almost thirteene degrees in foure and twenty houres, and the Sunne mooueth scarce one degree: which giues euery day twelue degrees, that the Moone commeth slower to any point in the heauen then the Sunne: which twelue degrees makes forty eight minutes of time for the difference of euery full Sea, according vnto the middle motion of the Moone, which difference is here set downe in this table for euery day of the Moones age. Therefore if you would knowe the full Sea at any place in the world, first you must know at what houre it is full Sea at the new or full Moone; which houres and minutes keepe in mind, then seeke the age of the Moone as is before taught, and with the number of her age enter this table, vnder the title of the Moones age, and hauing found her age in the table, against it you shall find the houres and minutes which are to be added vnto the time that the Moone maketh full Sea in any place, and the whole number of houres and minutes is the time that the Moone maketh full Sea in that place vpon the day desired. As for example, I desire to know the full Sea at London Bridge vpon the thirteene of Iuly 1624. the age of the Moone being found as before, is eight dayes, then in the Table I find eight dayes, and against it sixe houres and foure and twenty minutes, which being added vnto three houres, the full Sea vpon the change day giue nine a clocke 24. min. for the time of the full Sea vpon the thirteenth day of Iuly 1624.

FINIS.

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